

AMENDMENTS TO THE SPECIFICATION

Please amend the paragraph beginning at page 5, line 10, as follows.

fig. 3a the ohmic current/voltage characteristics of a ~~diode~~ PEDOT layer between copper electrodes according to prior art and manufactured according to two different processing protocols,

Please amend the paragraph beginning at page 5, line 12, as follows.

fig. 3b the current density/voltage ~~current/voltage~~ characteristics of a diode made by the method according to the present invention, and of a diode made according to prior art,

Please amend the paragraph beginning at page 5, line 15, as follows.

fig. 3c the current density/voltage ~~current/voltage~~ characteristics of a diode made by the method according to the present invention, and of a diode made according to prior art,

Please amend the paragraph beginning at page 5, line 18, as follows.

fig. 3d the current density/voltage ~~current/voltage~~ characteristics of a diode made by the method of the present invention, and of a diode made according to prior art,

Please replace the paragraph beginning at page 5, line 20, as follows.

fig. 3e the current density/voltage ~~current/voltage~~ characteristics of a diode made by the method according to the present invention, and of a diode made according to prior art,

Please amend the paragraph beginning at page 5, line 25, as follows.

fig. 4 a semilog plot of the current density/voltage ~~current/voltage~~ characteristics of a prior art diode and a diode according to the present invention, with insert showing the rectification ratio as a function of the voltage for the diode according to the present invention,

Please amend the paragraph beginning at page 7, line 33, as follows.

In each case the embodiments of fig. 2a and 2b ~~2~~ emerge as organic thin-film diodes in a sandwich construction.

Please amend the paragraph beginning at page 8, line 1 as follows.

Fig. 3a shows ohmic current/voltage characteristics of a prior art device in planar geometry made with PEDOT between copper electrodes, in that the curve with filled circles shows the characteristics of PEDOT spin-coated at 4000 rpm and the curve with open circles the characteristics of PEDOT spin-coated at 1000 rpm. The distance between the copper electrodes is approximately 1 mm and the characteristic is linear, which is typical of an ohmic resistance.

Please amend the paragraph beginning at page 8, line 8, as follows.

Fig. 3b shows the current density/voltage ~~current/voltage~~ characteristic expressed respectively through the forward current in the conducting direction and backward current in the blocking direction of a diode according to prior art (solid lines) and of a diode made according to the method of the present invention (lines

with circles/dots). The known diode is made with P3HT as the semiconducting material, spin-coated at 600 rpm from a 5 mg/ml solution and arranged between a copper anode and an aluminium cathode, respectively. The current in the forward direction is shown by the upper solid line and the current in the backward direction by the lower solid line. The diode made by the method according to the present invention has an anode 2, 3 made from a double layer of copper and PEDOT-PSS as the conducting polymer, spin-coated at 3000 rpm. The active semiconducting material P3HT is spin-coated at 600 rpm from a 5 mg/ml solution, and the cathode is made from aluminium. In this case the characteristic has been determined through two measurement series, and as can be seen from fig. 3b the results are virtually identical. The respective measurement series are discerned through curves with open or closed circles, respectively. The two upper, almost coinciding curves exhibit the current in the forward direction, while the lower curves exhibit the current in the backward direction. The difference compared to the diode made by conventional means is obvious.

Please amend the paragraph beginning at page 8, line 28, as follows.

Correspondingly fig. 3c shows the current density/voltage ~~current/voltage~~ characteristics of a diode according to prior art and a diode made according to the present invention. The diode according to known art employs MEH-PPV spin-coated at 800 rpm from a 5 mg/ml solution as the semiconductor material, arranged in sandwich between a copper anode and an aluminium cathode, respectively. Current/voltage characteristics are here represented by a curve with filled circles. The diode made by the method according to the present invention employs the same organic semiconductor material deposited under similar conditions, but again the anode is a double layer of copper with PEDOT-PSS spin-coated at 4000 rpm, and the cathode is made from aluminium. The characteristic in this case is shown as a curve with open circles and the difference between the characteristics of the known component and the component made by the method according to the present invention is again obvious.

Please amend the paragraph beginning at page 9, line 6, as follows.

Fig. 3d shows in the same way as in fig. 3c the current density/voltage ~~current/voltage~~ characteristics of the same

components, in that the conducting material and the active organic semiconducting material are deposited under exactly the same conditions respectively, but in both cases the anode is now made with aluminium.

Please amend the paragraph beginning at page 9, line 11, as follows.

Fig. 3e shows the current density/voltage ~~current/voltage~~ characteristics of a diode according to prior art and a diode made by the method according to the invention. The known diode employs active material consisting of MEH-PPV spin-coated at 600 rpm from a 5 mg/ml solution and arranged in sandwich between a nickel anode and an aluminium cathode. The characteristic is in this case shown by a curve with filled circles. The diode made by the method according to the present invention employs an anode made by a double layer of nickel and PEDOT-PSS spin-coated at 4000 rpm, while the active material is MEH-PPV spin-coated at 600 rpm from a 5 mg/ml solution, and the cathode is again aluminium. The characteristic is in this case shown by a curve with open circles.

Please amend the paragraph beginning at page 10, line 24 as follows.

A large effort has been undertaken towards fabrication of electronic devices using polymers. Most of these are directed towards field-effect transistors and diodes, in imitation of silicon electronics. Among the diodes, both light emitting diodes and light detecting diodes constitute the major fraction of the studies; in both of these a transparent electrode is suitable. However, a high rectification organic diode is quite important for a broad spectrum of electronic applications. In order to fabricate diodes based on semiconducting polymers with high rectification, one needs materials that allow efficient charge injection through the polymer under forward bias, and much less so under reverse bias. Normally this is achieved using materials that match in energy position, or make low potential barriers, to the HOMO (Highest Occupied Molecular Orbital) and LUMO (Lowest Unoccupied Molecular Orbital) levels of the polymer. In the reverse bias both barriers for electrons and holes must be high enough to keep the current low, having thus as a result a high rectification ratio. But it is not just the energy levels that matter. The interface properties and the quality of the polymer film formed onto a given metal can define the diode properties; often polymer film spin-coated onto inert materials such as gold presents pin holes

that are not acceptable if one needs to evaporate an upper electrode on top of the polymer film in a sandwich geometry. The conducting/semiconducting polymer interface tends to have good adhesion. The oxidized conducting polymer poly(3,4-ethylenedioxythiophene) doped with poly(4-styrene sulphonate) (PEDOT-PSS) was found to have the high work function value 5,2 eV which allows efficient hole injection in LEDs or collectors in photodiodes. However, the higher resistance of PEDOT-PSS compared with ordinary metals may compromise the diode performance in thin patterned lines, due to voltage drop under high currents. To handle this problem, a metal layer under the polymer is used. Any metal can be used as the underlying layer as it is not necessary to match the work function of the metal (ϕ_m) with the work function of PEDOT (ϕ_{PEDOT}). Since noble metals like gold and platinum which is commonly used in organic light-emitting diodes, are known to comport detrimental effects when used in conjunction with PEDOT, the preferred metals will be base metals with high conductivity. - The expression "base metals" as used herein, as opposed to noble metals, should be understood as metals with electrochemical potential less than 1 volt. - Diodes made with several metals (Al (4,2 eV), Ag (4,3 eV), Cu (4,5 eV)) were tested. In all cases the current flow of holes which was contact-limited, changed to

bulk-limited when a PEDOT-PSS layer was used between the anode metal and the semiconducting polymer MEH-PPV (poly(2-methoxy, 5-(2'-ethyl-hexyloxy)-1,4-phenylene vinylene)). In order to study the electrical properties of diodes with different active areas copper was chosen as the underlying layer, particularly due to its good stability and etching properties. The Cu/PEDOT-PSS interface was demonstrated to be ohmic with a contact resistance $r_c \approx 7 \frac{\Omega}{\square} \frac{\Omega}{\square}$. The ohmic behaviour of Cu/PEDOT-PSS interface is an important asset for its use as an electrode in diodes. The contact resistance of Cu/PEDOT-PSS interface was measured using planar geometry to provide a copper surface similar to that used for the diodes.

Please amend the paragraph beginning at page 12, line 18 as follows.

The I-V characteristics of two similar diodes made using MEH-PPV polymer is presented in fig. 4, which shows a semilog plot of the current density/voltage ~~current/voltage~~ characteristics of a MEH-PPV-based diode using a copper anode (open circles) and a similar MEH-PPV-based diode using a Cu/PEDOT-PSS anode (solid circles). The insert graph here shows a semilog plot of the rectification ratio versus the voltage for the diode with the Cu/PEDOT-PSS anode. The measurements were performed using a Hewlett Packard 4156A precision semiconductor parameter analyser in dark

environment. It is possible to notice the difference in the shape of the current-voltage dependence due to the inclusion of the PEDOT-PSS layer. Due to higher value of the work function of PEDOT-PSS (5.2 eV) compared to Cu (4.5 eV), the energy barrier for hole injection from PEDOT-PSS to the MEH-PPV is $\phi \cong 0.1$ eV. This is much smaller than that from Cu to MEH-PPV which is $\phi \cong 0.8$ eV, as the current limitation in this two situations are different. Copper presents a contact-limited current regime; in this low injection regime the current densities are small and space charge effects can be neglected. With the inclusion of a thin layer of PEDOT-PSS it will be possible to make a transition to a bulk-limited current regime where the forward current is mostly due to the positive carriers coming from the Cu/PEDOT-PSS electrode. The Cu/PEDOT-PSS/MEH-PPV/Al diodes presented a $J(V)$ function with three limiting regions, J being the current density. From 0 to 1 volt the current is at the noise level of the equipment; little charge flow occurs. This condition is due to the difference in the work function values of the electrodes (PEDOT-PSS and Al $\cong 1$ eV) which creates an inherent potential in the polymer layer that opposes hole injection. One first has to apply this voltage in order to inject charge. Between 1 and 2 volts the current has an exponential behaviour, and increases by five orders of magnitude. This dramatic

increase is a property of the interface PEDOT-PSS/MEH-PPV with its low energy barrier. Beyond 2 volts the current becomes dependent on the transport properties of the MEH-PPV layer. The insert graph in fig. 4 shows the rectification ratio value of this diode as a function of voltage, the rectification ratio being taken by dividing the forward by the reverse current. At 3 volts it already shows a rectification ratio of six orders of magnitude, increasing to seven between 4 and 8 volts. Beyond 8 volts the injection of holes from Al to MEH-PPV increases the reverse current decreasing the rectification ratio value.

AMENDMENTS TO THE DRAWINGS

Please replace Figures 3a-3f and 4-6 with the Replacement Drawings attached hereto.